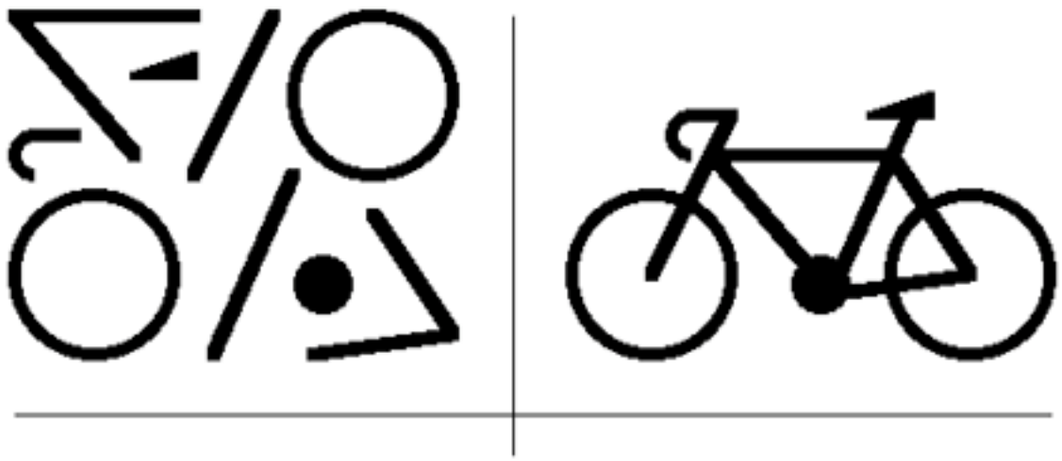
A Feature Integration Theory of Attention

A. Treisman and G. Gelade

(1980)

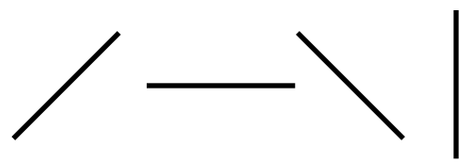
Analytic vs Synthetic

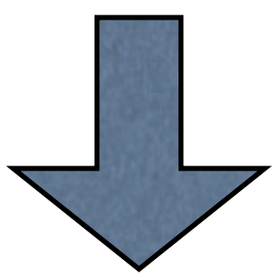


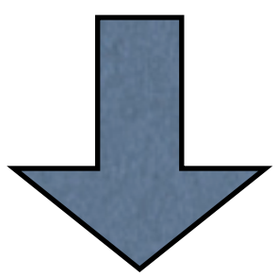
Gestalt Doubts

- Conforms to subjective experience
- No guarantee that this represents early stage of perception
- Needs more evidence as theory of actual coding

Features and Dimensions

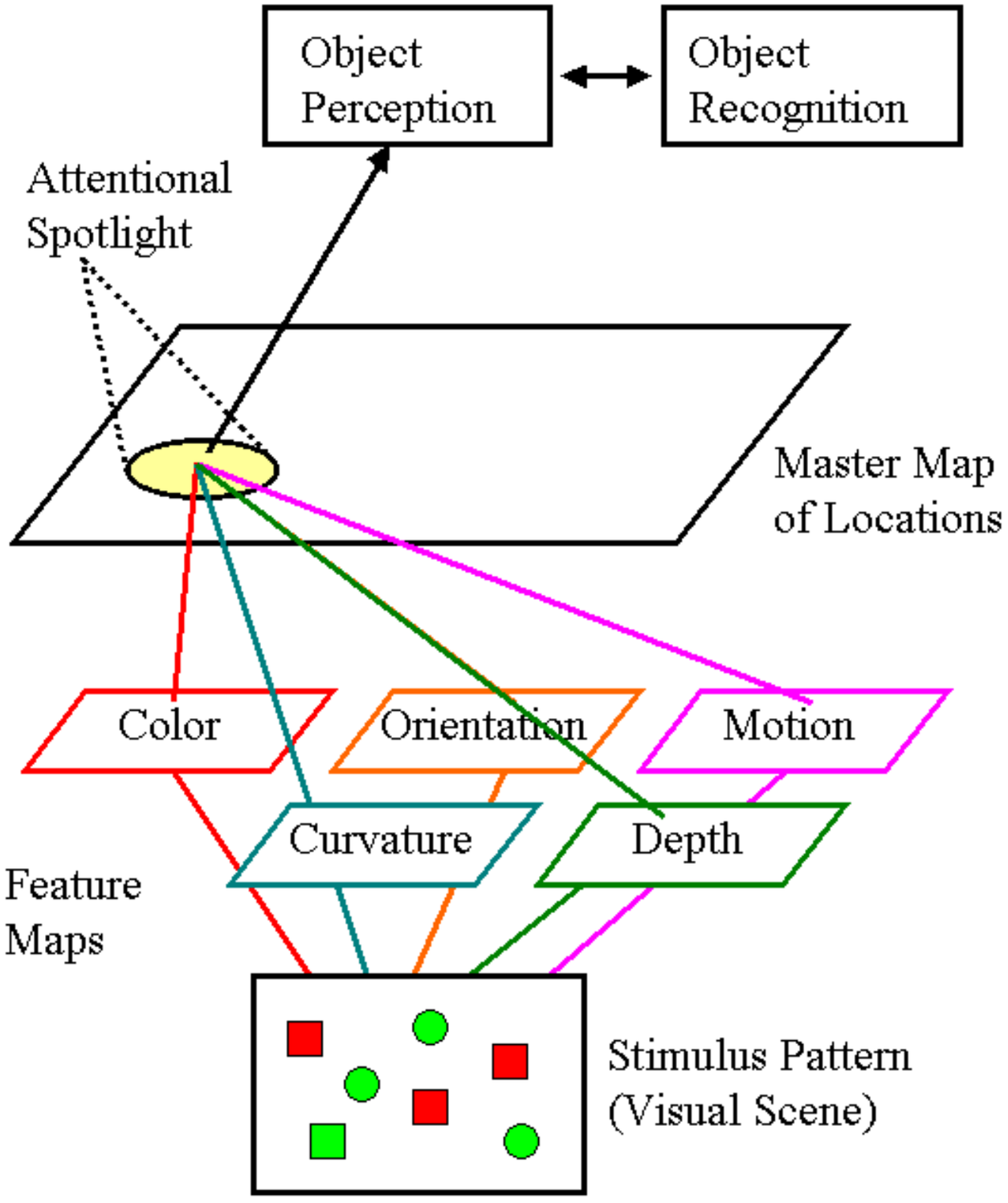


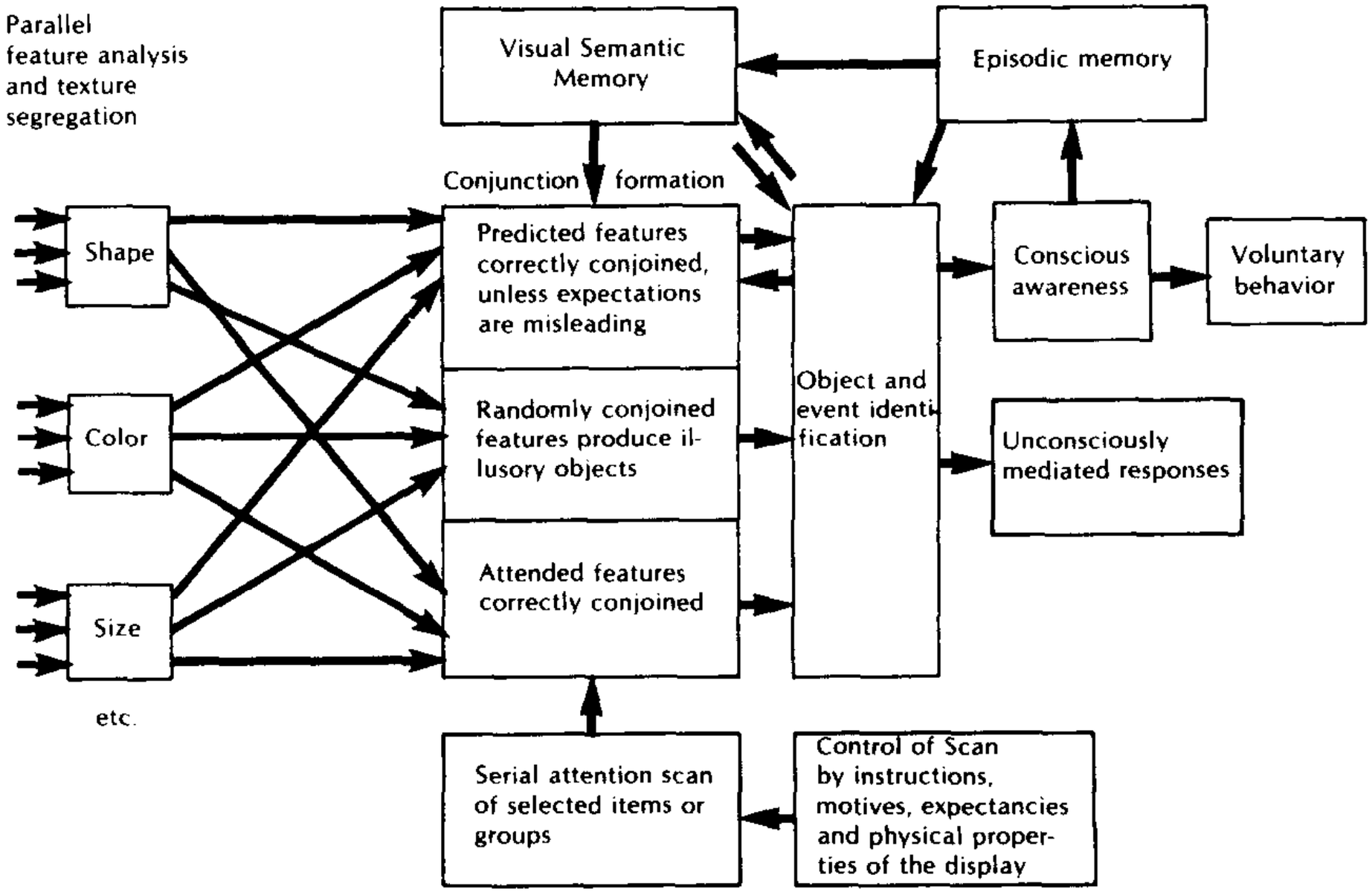




- A “feature” is a particular value on a dimension
- Separable features determined empirically

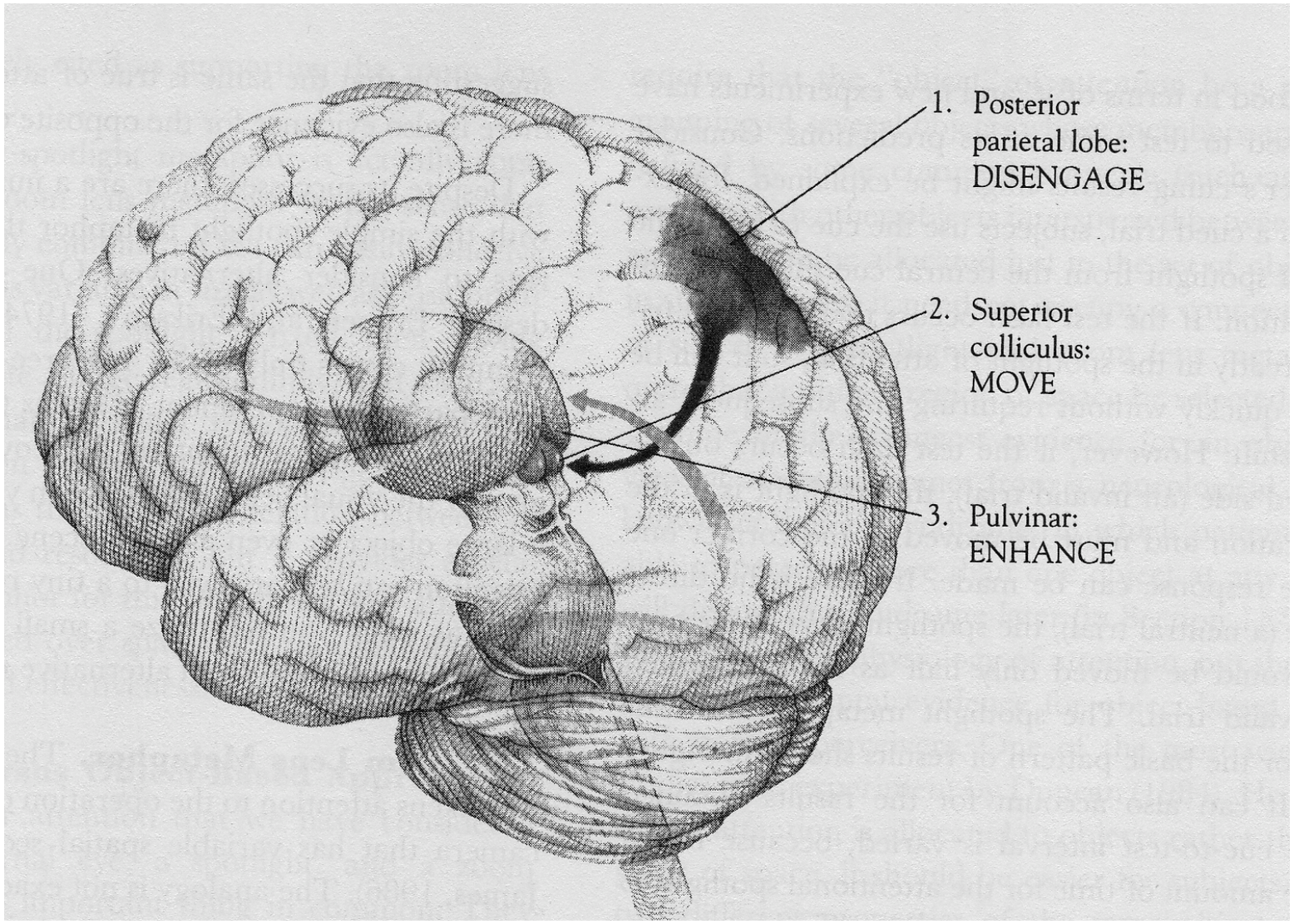
Feature Integration Theory





Treisman & Schmidt 1982

Neural Basis

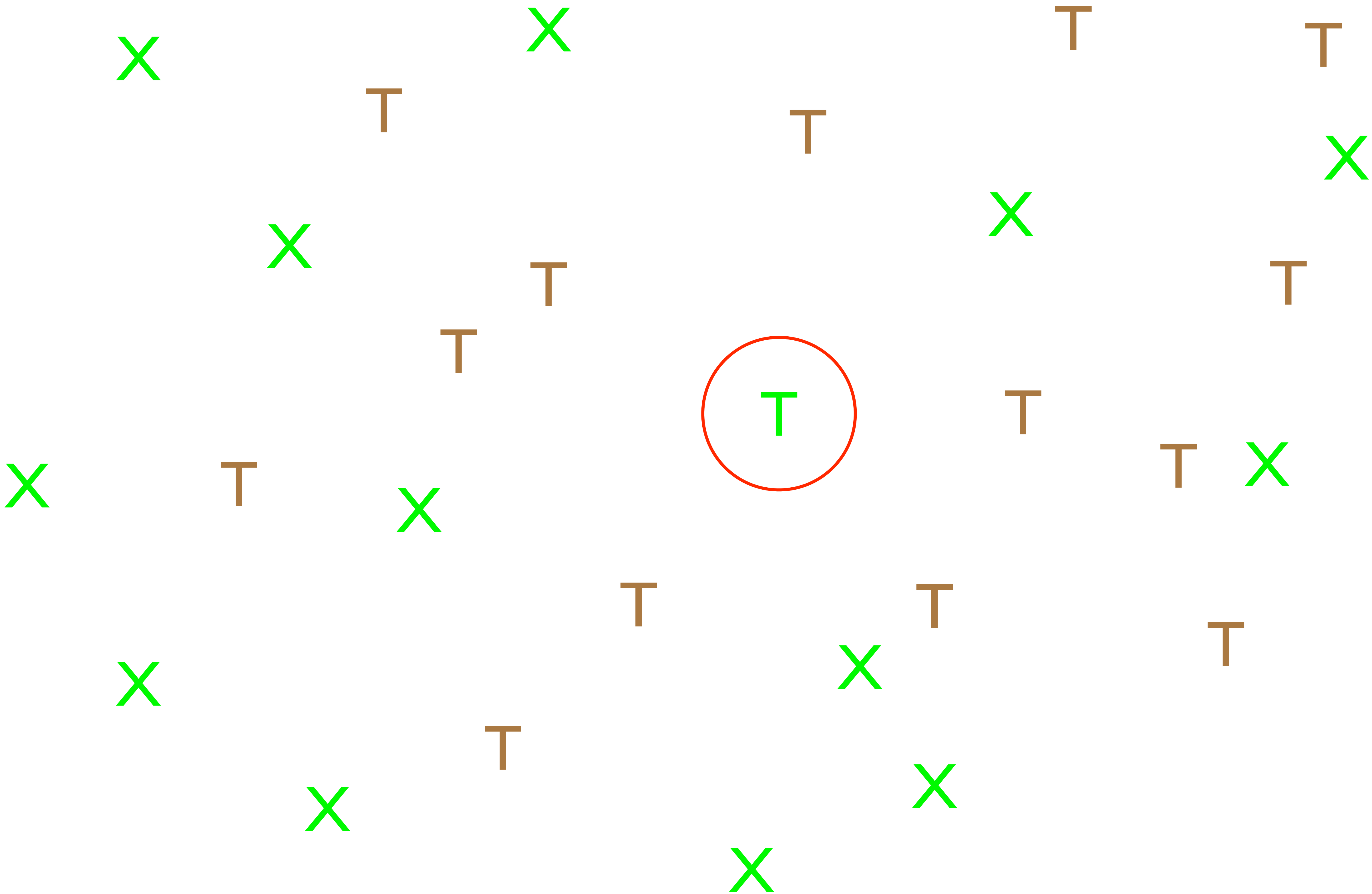


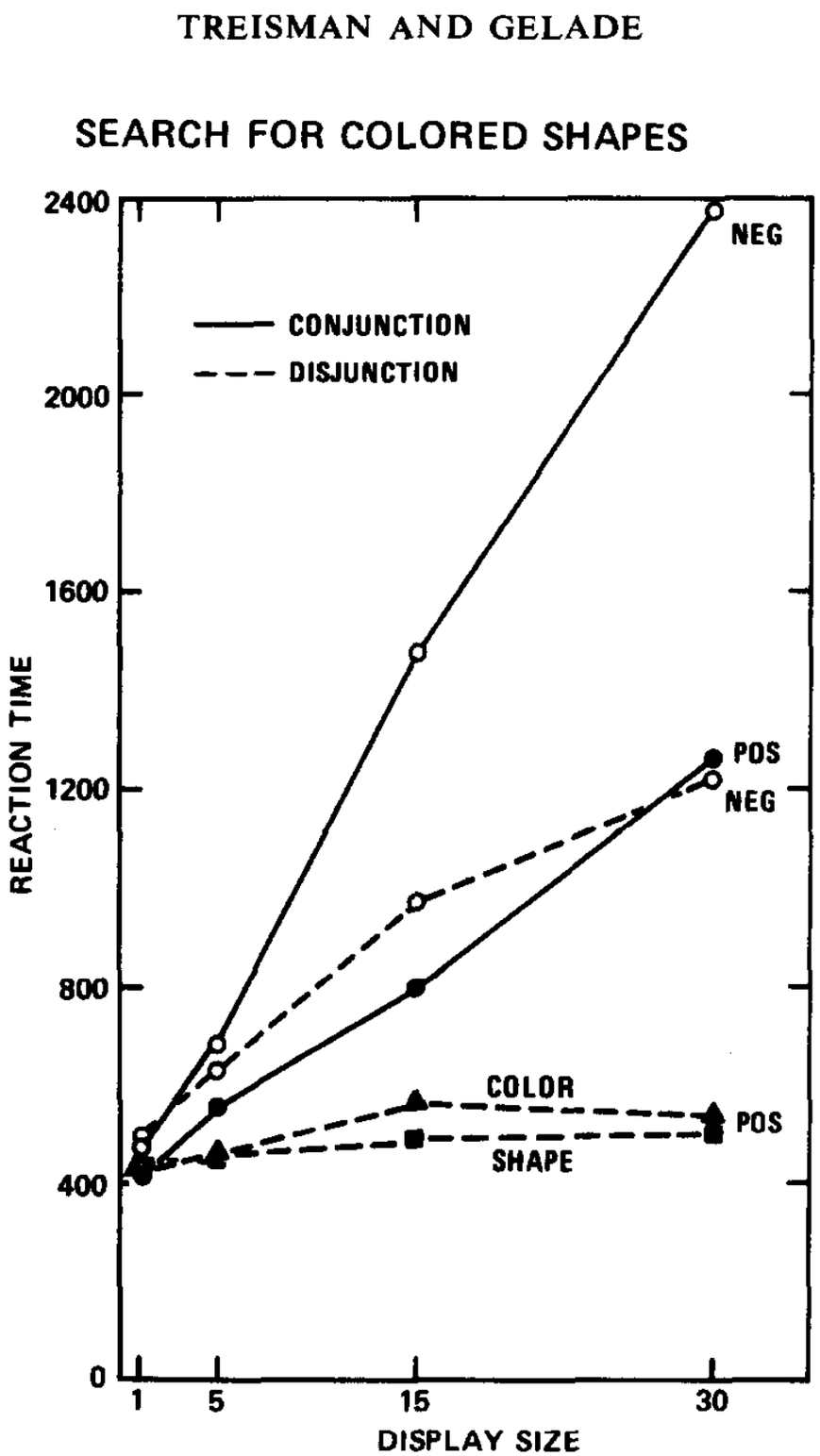
Predictions

- Parallel vs Serial search*
- Texture segregation*
- Illusory Conjunctions
- Identity and Location*
- Interference from unattended stimuli

Experiments 1-3: Visual Search

- Single features can be processed in parallel
- Conjunction of features processed serially
- Self-terminating search

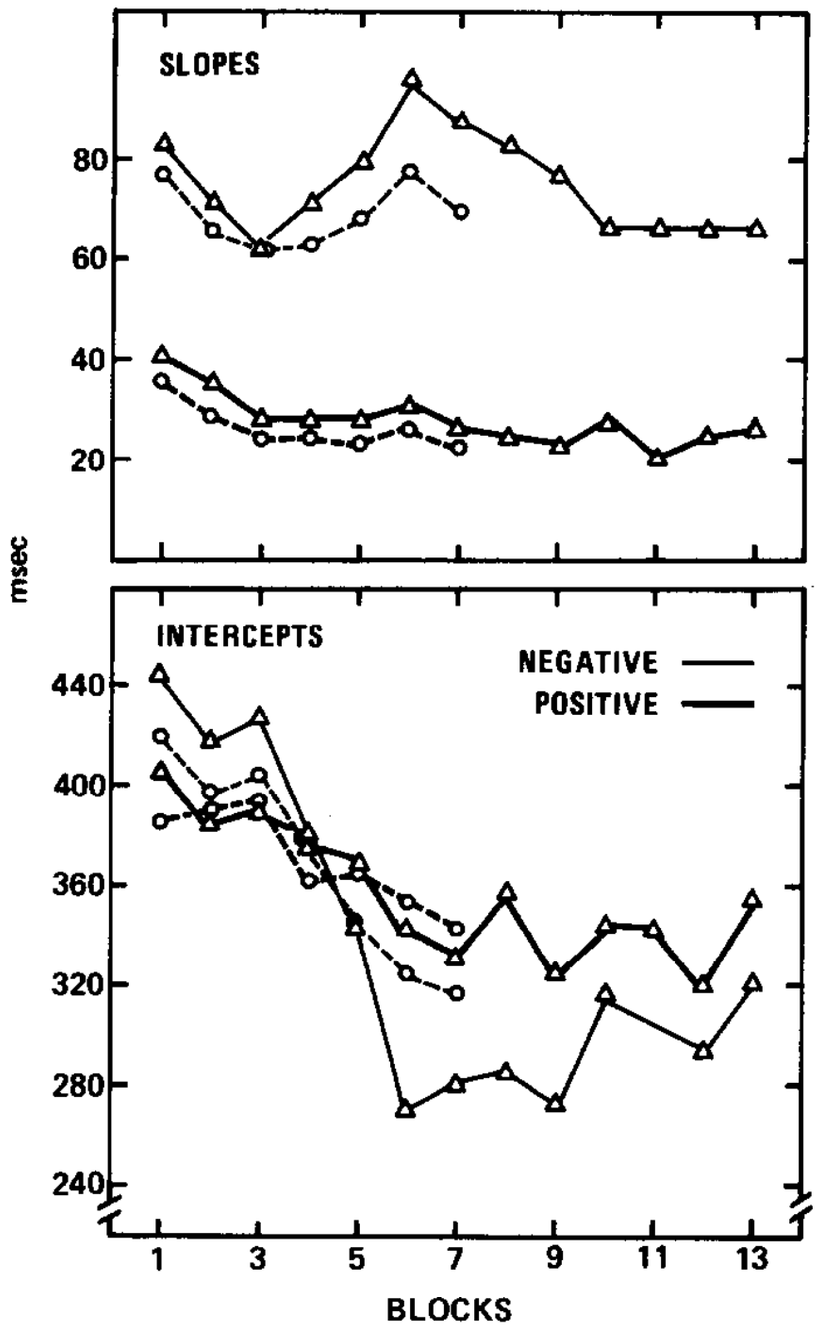




- 1664 Trials
- No error bars—could lend support if pos. had greater variation
- Positive color-only not significantly linear
- Negative conjunction has ~ twice the slope of positive conjunction (67 vs 29ms)

1664 Trials

No switch from serial to parallel



The Hard and the Easy

- Should be possible to affect speed of judgment based on similarity
- Should still have the 2/1 ratio of negative to positive slopes

N	O	N	O
O	N	O	N
O	N	O	O
N	N	O	N

⊥	X	X	⊥
⊥	⊥	X	X
X	⊥	⊥	⊥
⊥	X	⊥	X

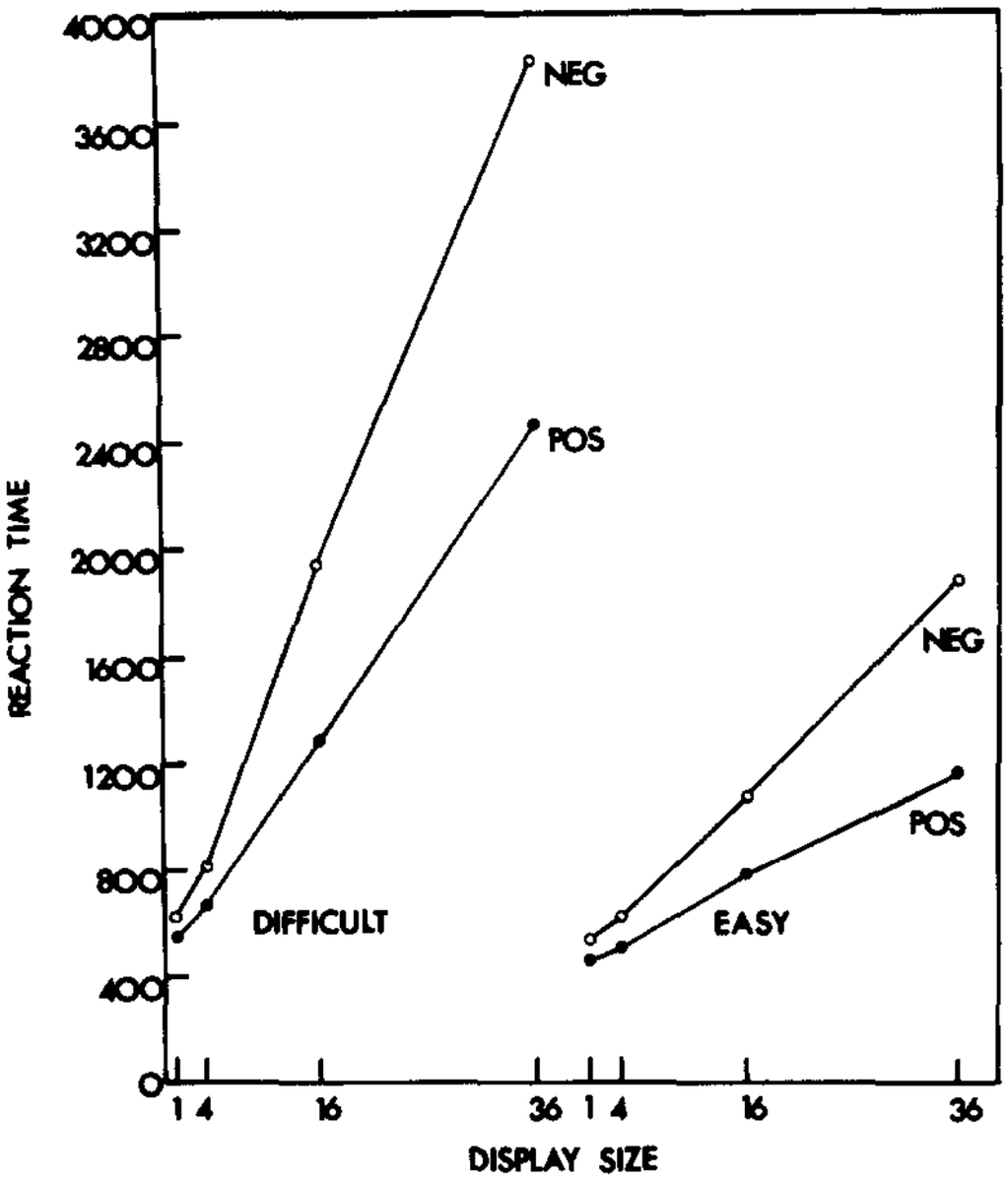


FIG. 3. Search times in Experiment II.

Linear Regressions of Search Times against Display Size in Experiment II

		Slope	Intercept	Percentage variance with display size which is due to linearity
Difficult discrimination	Positives	55.1	453	99.8
	Negatives	92.4	472	99.9
Easy discrimination	Positives	20.5	437	99.8
	Negatives	39.5	489	99.9

Discussion

- Higher error rates on “difficult” condition
- Still works on regular grid
- Slopes still retain 2:1 ratio

"Centrality"

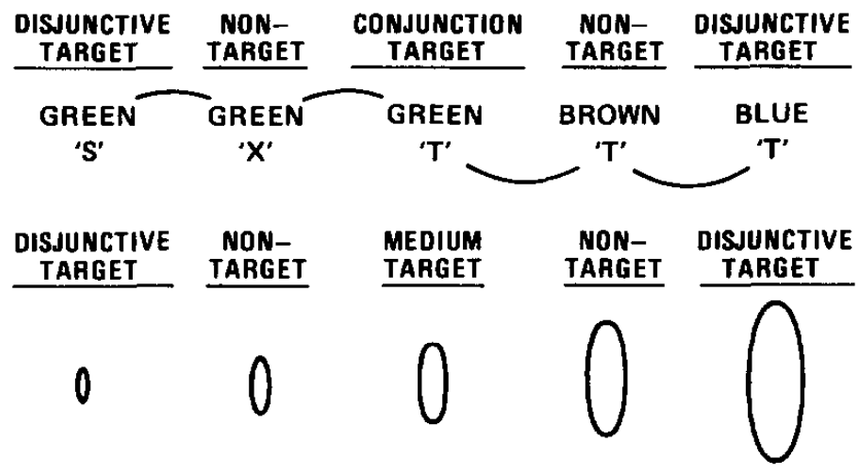


FIG. 4. Similarity relations between the stimuli in Experiments I and III.

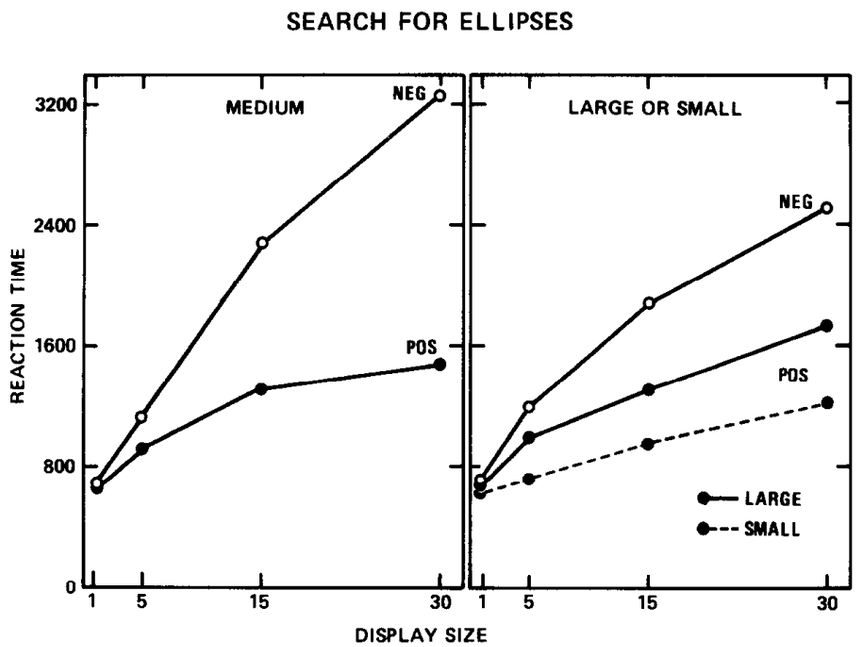
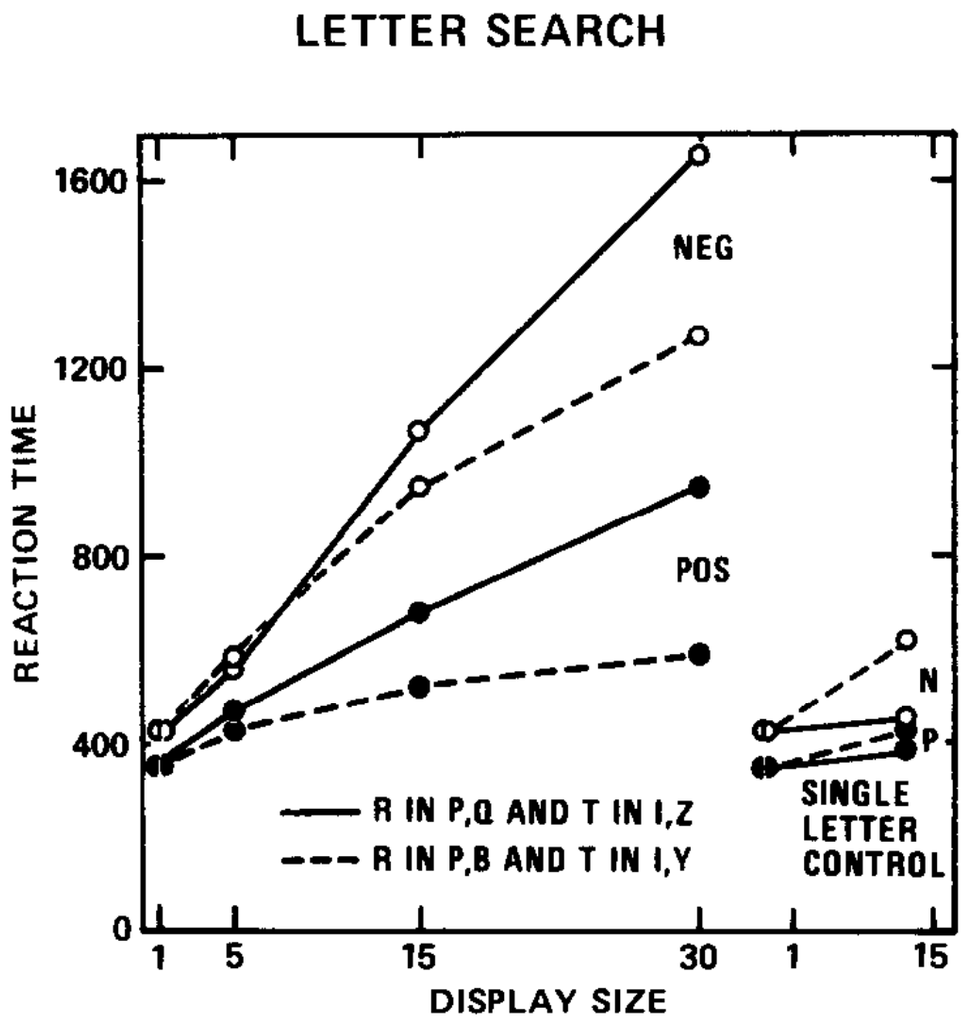


FIG. 5. Search times in Experiment III.

Experiment 4
Compound shapes

- Are letters perceptual "units"?
- Feature Integration: letters processed serially if:
  - They are analyzed as separate features
  - These features are interchangeable to form possible errors

$$P + Q \stackrel{?}{=} R \qquad P + B \neq R$$



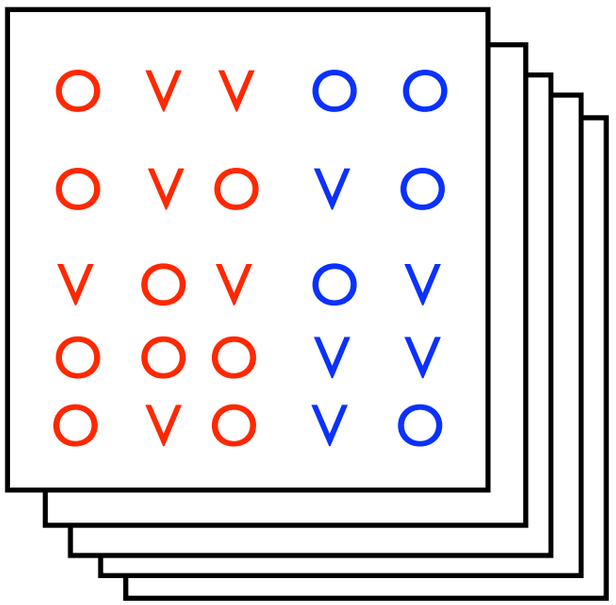
- Ratio in R|PQ case close to 2:1 (.45)

- In R|PB case, ratio is much lower (0.26), suggests different processes

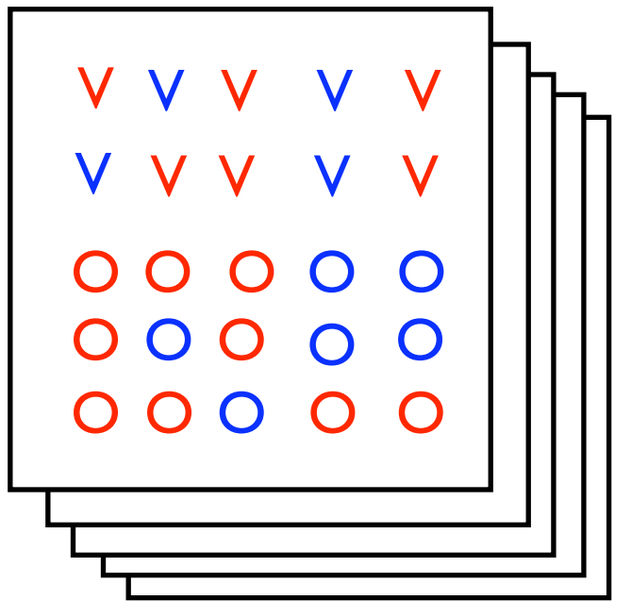
Experiments 5-7: Texture segregation

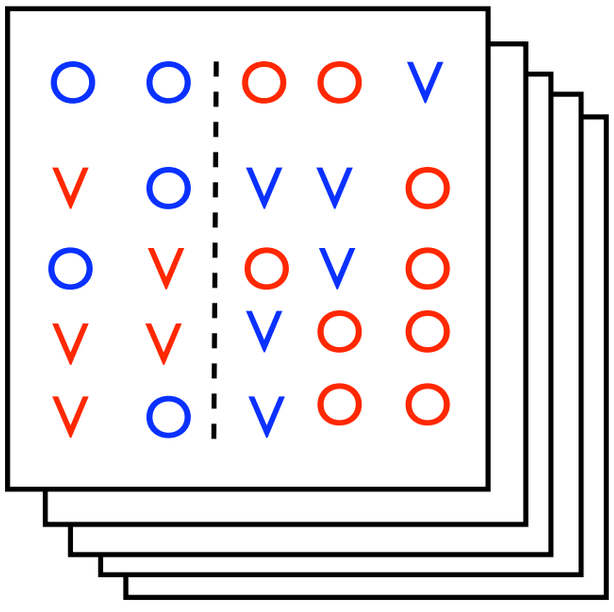
- Figure/Ground separation preattentive
- Determined by spatial discontinuities
- Easy segregation when areas differ in one separable feature (color, shape, etc.)

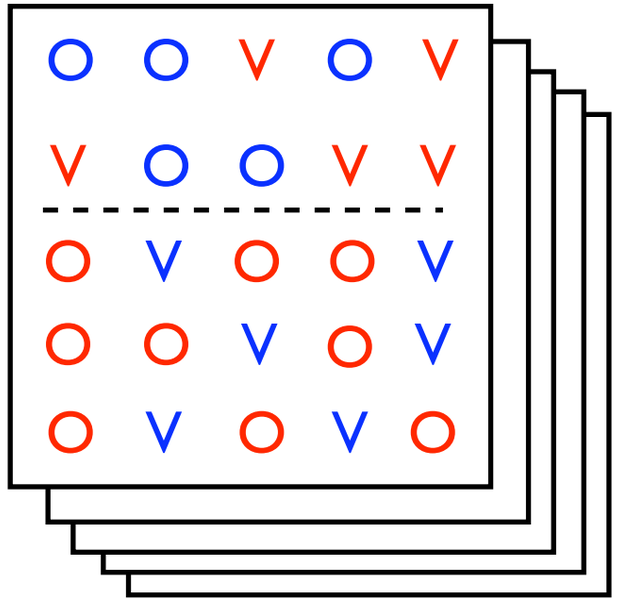
Vertical Boundary



Horizontal Boundary







Results

- Took significantly longer to sort conjunction sets than not (~25 s. vs. ~15 s)
- Conjunction sets did not differ from each other
- Most subjects developed same strategy of locating all instances of one conjunction (e.g. O)

Modifications

- Use multiple dimensions: Oπ on one side and OV on the other.
- Use letter sub-features:
  - PO vs RQ have diagonals only on one side
  - PQ vs RO has no simple features

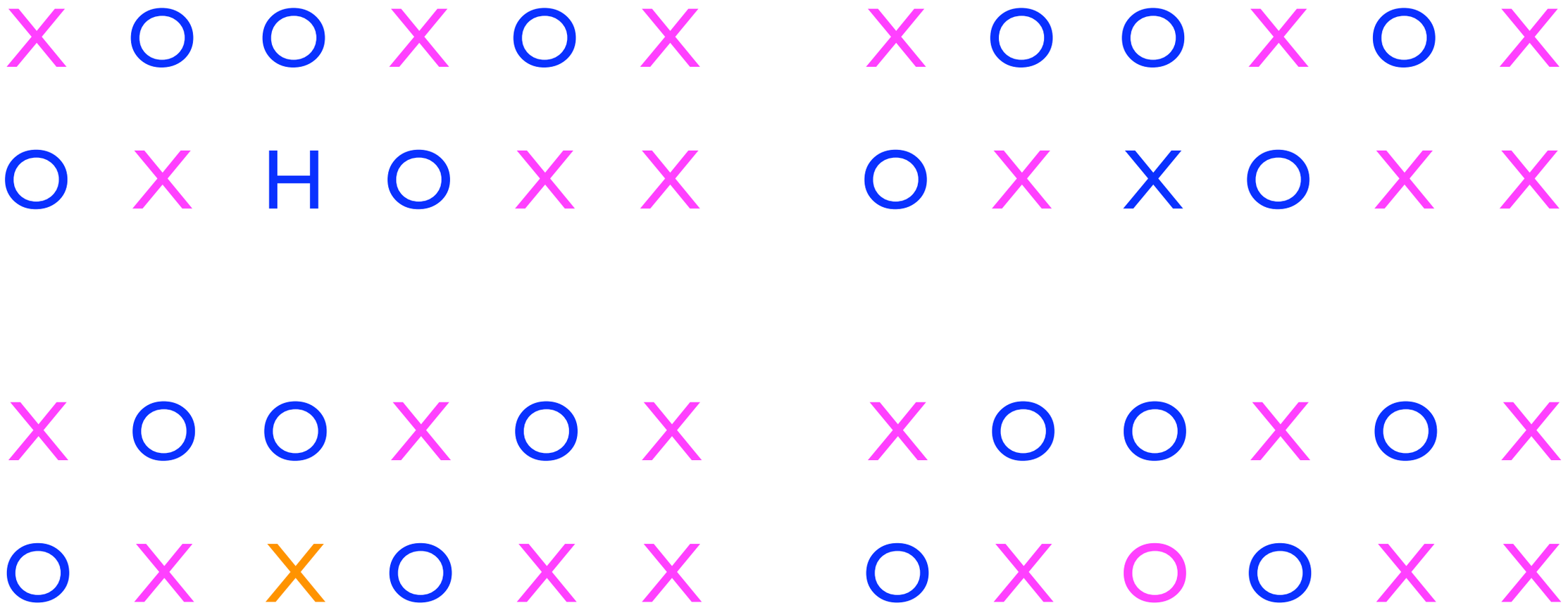
- Again, conjunction of features is the slower case
- One subject had vastly slower times on letter parts, so different strategies are possible

Experiments 8-9: Identity and Location

- If attention is prevented, features may be free-floating spatially and in relation to one another
- Locating a single feature separate from identification
- Conjunctions require attention, so location and identity are linked

Disjunctive

Conjunctive



Results

- Conditional probability of reporting identity correctly given location was wrong
- Chance performance = .5

Median Probabilities of Reporting the Target Identity Correctly Given Different Categories of Location Responses

		Location response			
		Correct	Adjacent	Distant	Overall
Experiment VIII	Conjunction	0.930	0.723	0.500	0.793
	Feature	0.897	0.821	0.678	0.786
Experiment IX	Conjunction	0.840	0.582	0.453	0.587
	Feature	0.979	0.925	0.748	0.916

Later work:
Illusory conjunction

2 X S T 5

- Low error rates on reporting digits (attention directed)
- Conjunction errors far exceed errors which combined correct and non-existent features

Problems with Feature Integration

- Highly distinctive features and higher-order features can be searched in parallel
- Retinotopy not consistent with eye movements
- None of these kill the theory, only make it more complicated

Summary

- Multiple feature detectors
- Parallel vs. Serial Search
- Free-floating features and locations